Geographical variation in dementia

eAppendix 1a. WinBUGS code: Swedish model (age-adjusted)

```
model {
for(i in 1:NPeople) {
Y[i] ~ dbern(p[i])
logit(p[i]) <- alpha + beta.age*AGE[i] + twin.re[TWIN[i]] + V[AREA[i]] + U[AREA[i]]
             }

# TWIN-LEVEL RANDOM EFFECTS (NTwins = number of twins; NMZ = number of MZ twins)
for(j in 1:NMZ) {
             twin.re[j] ~ dnorm(0, prec.mz)    # Random effects for MZ twins
             }
for(k in  (NMZ+1):NTwins) {
             twin.re[k] ~ dnorm(0, prec.dz)    # Random effects for DZ twins
             }

# AREA-LEVEL EFFECTS
# Unstructured effects (V)
for(l in 1:NArea) {
                   V[l] ~ dnorm(0, prec.v)

                   area.effect[l] <- exp(V[l] + U[l])
}

# Spatially correlated effects (U)
             U[1:NArea] ~ car.normal(adj[], weights[], num[], prec.u)
             for(m in 1:sumNumNeigh) {weights[m] <- 1}

# PRIORS
       alpha ~ dflat()
       beta.age ~ dnorm(0, 0.00001)
       prec.mz ~ dgamma(0.5, 0.0005)
       prec.dz ~ dgamma(0.5, 0.0005)
       prec.v ~ dgamma(0.5, 0.0005)
       sigma2.v <- 1/prec.v
       prec.u ~ dgamma(0.5, 0.0005)
       sigma2.u <- 1/prec.u
       sigma2.u.marginal <- sd(U[]) * sd(U[])

# OUTCOME MEASURES
       OR.age <- exp(beta.age)
       # Fraction of total variation in log odds due to spatial effects
       frac.spatial <- sigma2.u.marginal / (sigma2.u.marginal + sigma2.v)
# 90 percent quantile ratio
       QR90 <- ranked(area.effect[], N95) / ranked(area.effect[], N5)
}
```

eAppendix 1b. WinBUGS code: Scottish model (age-adjusted)

```
model {
for(i in 1:NPeople) {
Y[i] ~ dbern(p[i])
logit(p[i]) <- alpha + beta.age*AGE[i] + V[AREA[i]] + U[AREA[i]]
             }

# AREA-LEVEL EFFECTS
# Unstructured effects (V)
for(l in 1:NArea) {
             V[l] ~ dnorm(0, prec.v)
             area.effect[l] <- exp(V[l] + U[l])
}

# Spatially correlated effects (U)
       U[1:NArea] ~ car.normal(adj[], weights[], num[], prec.u)
       for(m in 1:sumNumNeigh) {weights[m] <- 1}

# PRIORS
       alpha ~ dflat()
       beta.age ~ dnorm(0, 0.00001)
       prec.v ~ dgamma(0.5, 0.0005)
       sigma2.v <- 1/prec.v
       prec.u ~ dgamma(0.5, 0.0005)
       sigma2.u <- 1/prec.u
       sigma2.u.marginal <- sd(U[]) * sd(U[])

# OUTCOME MEASURES
       OR.age <- exp(beta.age)
       # Fraction of total variation in log odds due to spatial effects
       frac.spatial <- sigma2.u.marginal / (sigma2.u.marginal + sigma2.v)
# 90 percent quantile ratio
       QR90 <- ranked(area.effect[], N95) / ranked(area.effect[], N5)
}
```

eTable 1. Rates of record linkage in men and women and mean intelligence in linked and untraced participants (both sexes pooled) in the 1932 Scottish Mental Survey Cohort by county of school attended age 11

County	Linkage rate		Linked		Untraced		
	Men	Women	N	mean±SD IQ	N	mean±SD IQ	P
Aberdeen	51.4	47.8	1993	102.2±14.5	1957	101.5±14.3	0.107
Aberdeenshire	50.1	50.1	935	97.2±15.0	957	95.7±15.5	0.030
Argyll	42.1	43.6	495	102.2±16.1	364	101.1±15.9	0.318
Ayr	46.6	47.8	3901	97.5±16.1	3498	96.1±15.8	<0.001
Banff	51.4	47.8	586	99.5±15.4	582	99.3±14.3	0.816
Berwick	39.9	49.8	219	104.8±14.8	183	104.3±15.6	0.767
Bute	31.4	43.6	142	100.3±15.0	83	103.8±15.0	0.091
Caithness	42.9	48.6	254	101.5±16.7	211	101.4±16.7	0.905
Clackmannan	44.3	43.2	348	99.0±15.5	272	98.4±14.7	0.675
Dumfries	40.9	41.1	850	103.2±15.8	596	104.2±14.8	0.207
Dunbarton	40.0	42.0	1657	101.6±14.6	1162	102.7±14.0	0.043
Dundee	44.3	44.6	1675	102.2±14.1	1371	101.8±14.4	0.374
East Lothian	48.7	51.4	398	100.7±15.0	410	99.5±15.4	0.233
Edinburgh	41.2	46.2	3750	102.6±14.5	2961	100.9±14.3	<0.001
Glasgow	39.2	41.3	11276	100.0±15.1	7652	99.8±14.7	0.374
Inverness	43.8	37.3	445	98.5±16.1	301	99.8±16.2	0.293
Kincardine	48.3	50.8	233	99.7±15.4	230	99.4±14.0	0.775
Kinross	46.8	39.6	57	99.7±15.6	41	97.8±14.8	0.532
Kirkcudbright	39.1	45.2	301	100.4±14.5	226	100.7±14.3	0.832
Lanark	39.0	43.0	6560	99.5±14.8	4607	99.3±14.5	0.374
Midlothian	51.3	46.2	863	99.9±15.5	828	98.9±14.4	0.175
Moray	47.0	49.0	393	101.7±13.9	361	101.9±14.4	0.854
Nairn	45.0	35.9	80	100.5±14.4	54	97.4±16.2	0.252
Orkney	56.3	56.1	139	96.7±16.4	177	96.4±15.1	0.857
Peebles	40.7	48.4	121	100.7±15.6	102	102.3±14.2	0.444
Perth	42.7	47.4	1010	102.4±15.2	844	101.7±14.6	0.318
Renfrew	38.8	38.4	3053	99.9±14.7	1956	99.8±14.7	0.804
Ross & Cromarty	46.6	49.8	519	96.3±16.0	480	96.0±16.0	0.816
Roxburgh	40.9	44.3	387	102.4±14.2	287	101.8±13.5	0.568
Selkirk	47.6	47.8	202	100.6±15.5	183	103.9±13.7	0.026
Stirling	46.0	45.1	1681	100.5±14.8	1414	99.9±13.8	0.251
Sutherland	47.1	49.6	113	102.2±17.1	106	101.2±13.6	0.626
West Lothian	47.4	49.9	906	98.0±14.3	858	97.8±15.2	0.789
Zetland	56.6	53.2	138	100.8±16.1	172	101.1±15.5	0.854

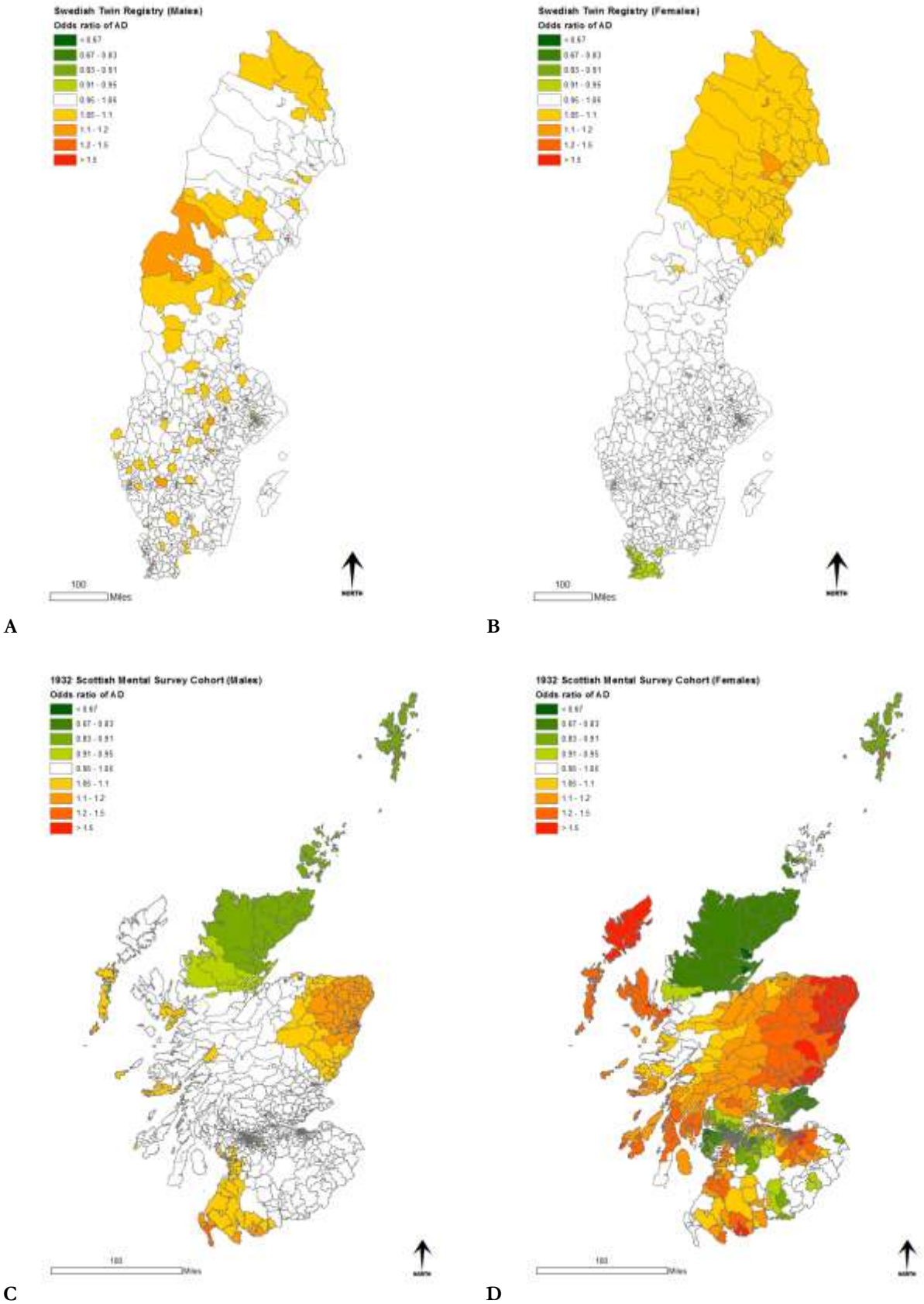
Data for Angus, Fife, and Wigtown were not available in the original 1932 SMS dataset.

eTable 2. Comparing dementia ascertainment from mortality records with diagnoses recorded on hospital discharge

		Hospital discharge data					
		Men			Women		
		No dementia	Dementia	Total	No dementia	Dementia	Total
Mortality records	No dementia	17970	233	18203	16040	375	16415
	Dementia	366	703	1069	624	1286	1910
	Total	18336	936	19272	16664	1661	18325

eTable 3. Sensitivity analysis – Scottish models – estimating underdiagnosis of dementia using primary care records

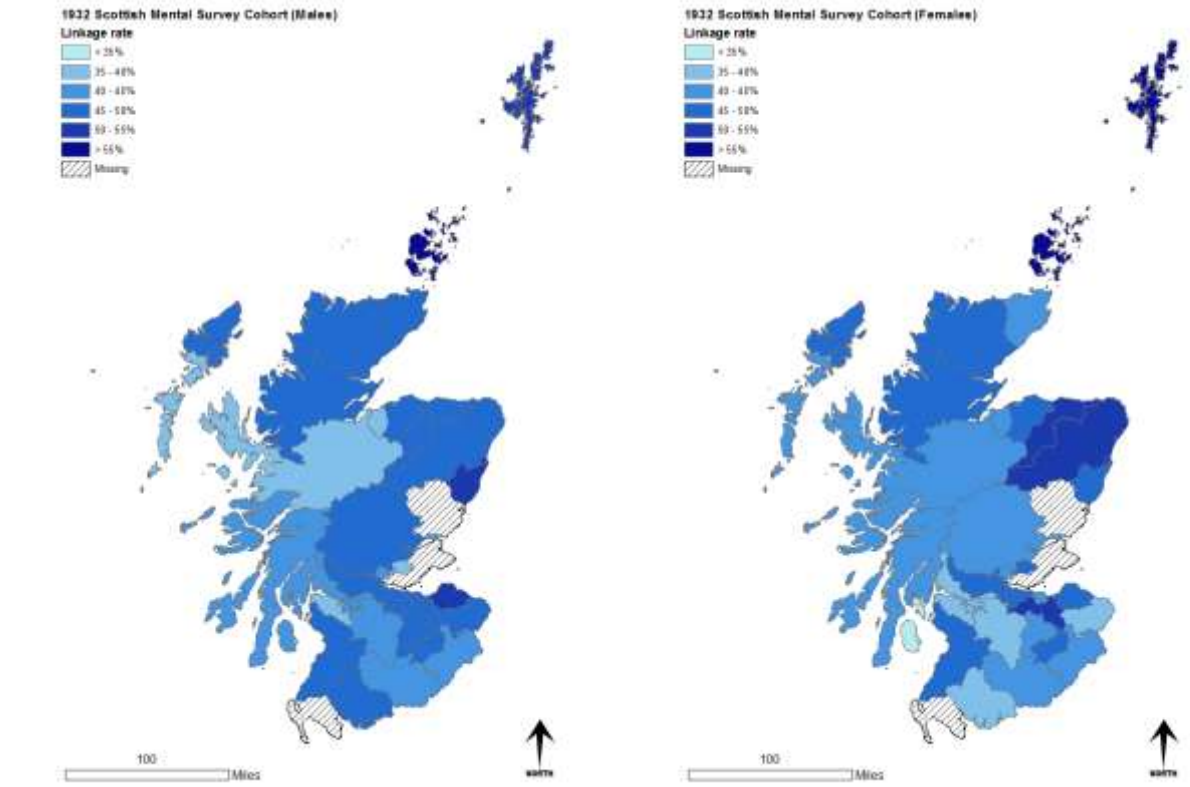
		Men			Women		
		Primary care records			Primary care records		
		No dementia	Dementia	Total	No dementia	Dementia	Total
Record linkage	No dementia	6	4	10	12	13	25
	Dementia	4	4	8	3	11	14
	Total	10	8	18	15	24	39



A **B**

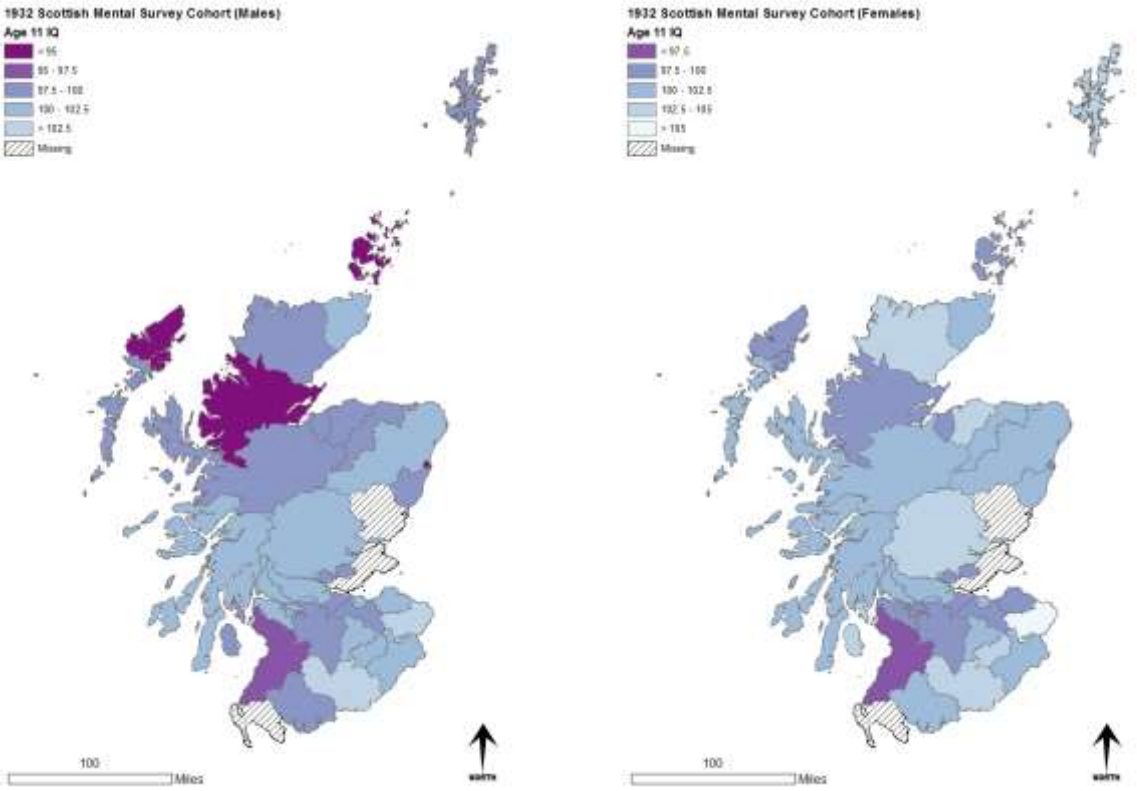
C **D**

eFigure 1. Age -adjusted area effects for Alzheimer disease in the Swedish Twins (A, male; B, female) and in the SMS1932 cohort (adult location; C, male; D, female)



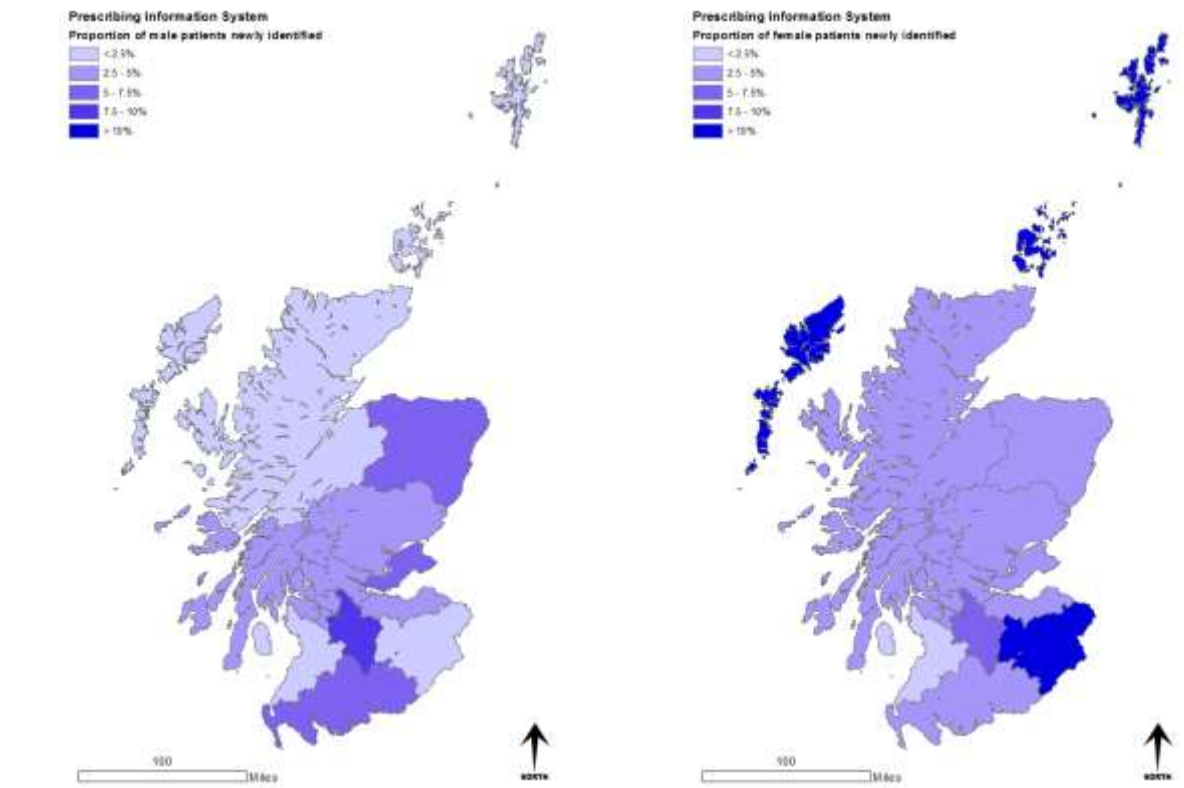
A **B**

eFigure 2. Rates of record linkage in men (A) and women (B) in the 1932 Scottish Mental Survey Cohort by county of school attended age 11. Data for Angus, Fife, and Wigtown were not available in the original SMS1932 dataset



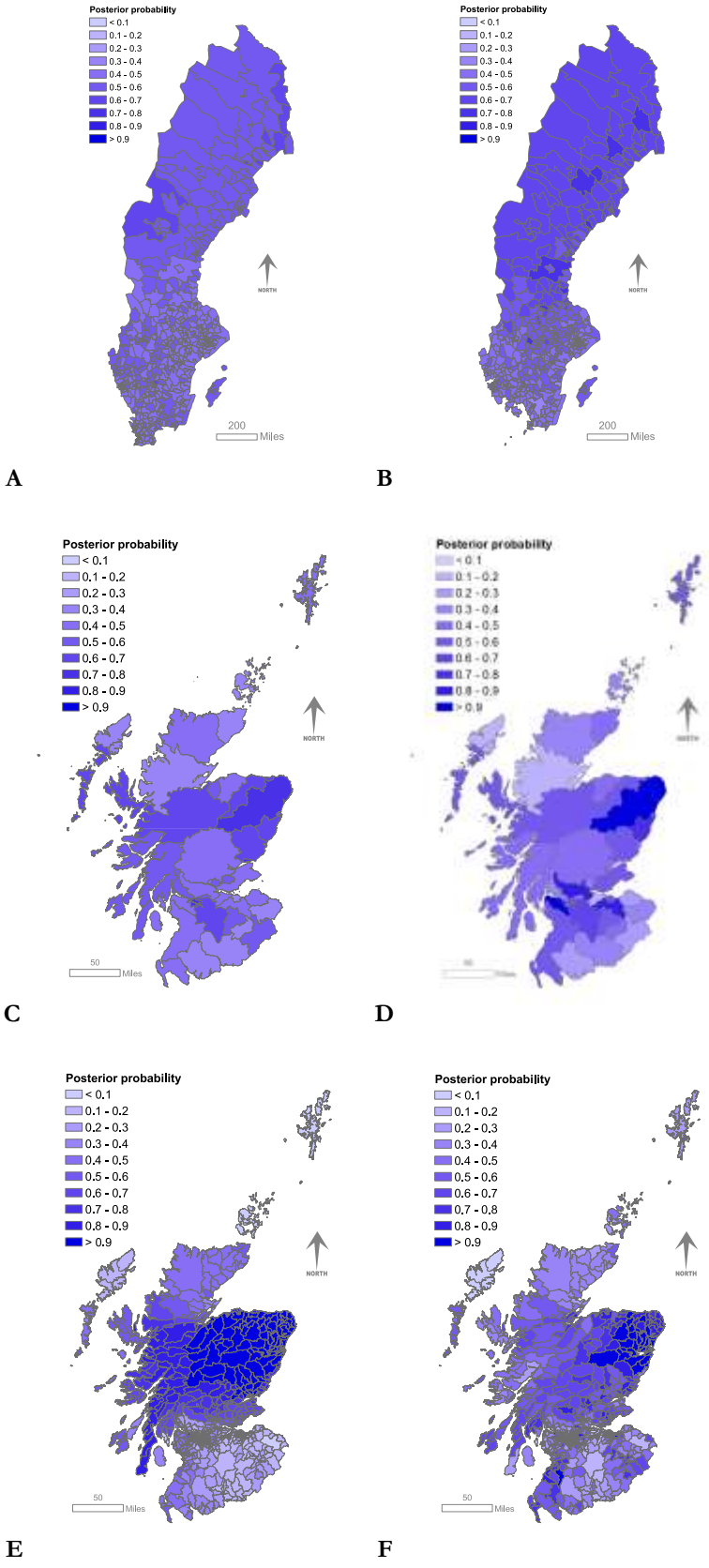
A **B**

eFigure 3. Map of IQ at age 11 by county in men (A) and women (B) in the whole SMS1932 cohort. Data for Angus, Fife, and Wigtown were not available in the original SMS1932 dataset



A **B**

eFigure 4. Rates of patients born in 1921 with dementia newly identified by the Prescribing Information System as having been dispensed one or more prescription item for a drug for dementia (a cholinesterase inhibitor or memantine) and who were not identified by hospital admission or mortality records as having been diagnosed with dementia (A, male; B, female). The definition of dementia used was identical to the one used in the main study (ICD-10 codes F00-F04, F05.1, F09, G30, and G31)



eFigure 5. Posterior probability of disease mapping models in Swedish twins (A, male; B, female); the SMS1932 cohort in childhood
(C, male; D, female); and the SMS1932 cohort in adulthood (E, male; F, female)